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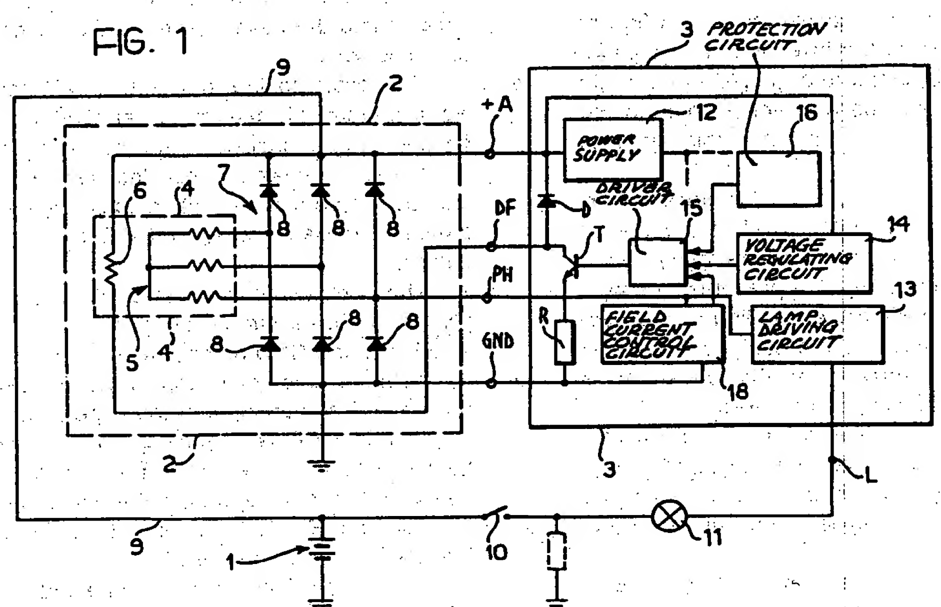
(54) A monitoring circuit for a system for recharging a motor vehicle battery.

(57) The circuit comprises

- a detector circuit (19-22) connected to a phase of the generator (2) and adapted to provide a signal indicative of the rotary speed of the generator (2), and
- a processing and comparison circuit (23) coupled to the said detector circuit (19-22) and adapted to generate a signal for controlling the conduction of current through the said transistor (T) which monitors the current in the field coil (6) so that the strength of the current flowing thought the collector-emitter path of the said transistor (T) varies as a function of the rotary speed of the said generator (2).

FIG. 1



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The present invention relates to a monitoring circuit for a motor vehicle battery recharging system which comprises a rotary electric generator including an alternator with an induction coil and a field coil and a rectifier the output of which is connected to the battery.

More specifically, the invention relates to a monitoring circuit which comprises
a driver transistor, the collector-emitter path of which is intended to be connected in series to the field coil of the generator between the two terminals of a direct current voltage source,
sensor means adapted to provide a signal indicative of the current flowing during operation of the said field coil and
driver circuit means adapted to drive the said transistor in accordance with predetermined procedures as a function of the value assumed by the voltage produced by the said generator and the signal provided by the said field current sensor means.

A monitoring circuit of the above-specified type is described for example in earlier European Patent Application EP-A-O 483 081.

The monitoring circuit according to the invention is of such a type and is characterised in that the aforesaid driver circuit means comprise
a detector circuit connected to a phase of the generator and adapted to provide a signal to indicate the rotary speed of the generator and
a processing and comparison circuit coupled to the said detector circuit and adapted to generate a signal for controlling the conduction of current through the transistor so that the intensity of the current flowing through the collector-emitter path of the said transistor varies as a function of the rotary speed of the said generator.

More specifically, in accordance with a further characteristic feature of the invention, the processing and comparison circuit is arranged to generate a signal for controlling the conduction through the said transistor in such a way that this latter is driven

- in a first mode which, when functioning, corresponds to a predetermined low value of current in the field coil when the rotary speed of the generator is below a preset level and
- in a second mode corresponding to a preset upper mean value of the said current when the speed of rotation of the generator is greater than the said preset level.

The monitoring circuit according to the invention makes it possible in particular to avoid a high absorption of current when the motor vehicle is stationary or when the engine of the motor vehicle is switched off.

Further characteristic features and advantages of the invention will emerge from the following detailed description given with reference to the attached drawings which are provided solely by way of non-limitive example and in which:

Figure 1 is a diagram showing a system for recharging the battery of a motor vehicle, comprising a monitoring circuit according to the invention,

Figure 2 is a block circuit diagram showing the monitoring circuit according to the invention,

Figure 3 is a diagram of an embodiment of a detector circuit contained within the monitoring circuit according to the invention and

Figures 4 and 5 show two embodiments of a processing and comparison circuit comprised within the control circuit according to the invention.

With reference to Figure 1, for recharging the battery 1 of a motor vehicle, a system is employed which comprises a current generator 2 and a monitoring circuit generally designated 3 and preferably constructed as an integrated circuit.

In per se known manner, the generator 2 comprises an alternator 4 with a three-phase induction coil 5 (in the example of embodiment illustrated, this has a star connection) and a field coil 6.

The induction coil 5 of the alternator is connected to a three-phase rectifier 7 of the double semi-wave type, produced using semi-conductor diodes 8.

The output from the rectifier 7 which constitutes the output from the generator 2 as a whole is connected to one terminal of the battery 1 through a connecting lead 9.

Reference numeral 10 denotes a switch connected to the positive terminal of the battery 1 and adapted to be actuated manually, for example by a key. The said switch may for example be incorporated into the ignition and starter selector switch of the vehicle.

Connected to the switch 10 is a terminal of a warning light 11, the other terminal of which is connected to an input L of the monitoring circuit 3.

In per se known manner, the warning light 11 is intended to be actuated (illuminated) when, with the switch 10 closed, the generator 2 is not generating current.

The control circuit 3 comprises a voltage supply 12 and has a further four terminals indicated as A, DF, PH and GND respectively.

Terminal A is connected to the output from the generator 2 and an input of the supply 12.

Terminal DF is connected to one end of the field coil 6, the other end of the said coil being connected to the output from the generator 2.

Terminal PH is connected to a phase of the induction coil 5 of the alternator 4.

Finally, terminal GND is connected to the earthing terminal of the rectifier circuit 7.

In per se known manner, the control circuit 3 comprises a driver circuit 13 for the light 11 and having the input connected to the terminal PH and therefore to a phase of the alternator 4.

In operation, when the switch 10 is closed and the alternator 2 is shut down, the circuit 13 in per se known manner causes illumination of the light 11.

As soon as the alternator 4 is actuated and the signal at the input PH exceeds the threshold of a comparator circuit within the driver circuit 13, the latter extinguishes the light 11.

The control circuit 3 also comprises (still in per se known manner) a voltage regulator circuit 14 with an input connected to the terminal A and therefore to the output from the generator and with the output connected to a driver circuit 15. This latter is connected at its output to the base of a transistor T consisting, for instance, of a Darlington transistor.

The transistor T has its collector connected to the terminal DF and its emitter connected to earth through a resistor R. The collector-emitter path of the transistor T is therefore in series with the resistor R and the field coil 6, between the output from the generator 2 and earth.

D indicates a flyback diode connected between terminals A and DF of the monitoring circuit 3. The said diode is therefore in parallel with the field coil 6.

Also connected to the driver circuit 15 are protective circuits 16 of equally per se known type, intended to cut off the transistor T if there is an excessive rise in temperature or in the event of an electrical overload.

The monitoring circuit 3 further comprises a circuit 18 for controlling the field current. The circuit 18 has an input connected to the emitter of the transistor T and has another input connected to the terminal PH and therefore to a phase of the induction coil 5 of the generator 2.

The output of the circuit 18 is connected to a further input of the driver circuit 15.

As Figure 2 shows, the circuit 18 comprises a threshold comparator 19 with the reversing input connected to a reference DC voltage source 20, and a non-inverting input connected to the terminal PH and therefore to a phase of the field coil 5 of the generator 2.

Between the non-inverting input of the comparator 19 and earth there is a current source 21 consisting, for instance, of a current generator producing power at around 1 mA and intended to neutralise the effect of any leakage currents from the diodes 8 of the rectifier bridge 7.

The output from the threshold comparator 19 is connected to the input of a phase signal detector circuit generally designated 22. The said circuit is arranged to provide at its output a logic signal which assumes, for example, the level "O" when the rotor of the generator 2 is stopped or is rotating very slowly (at a speed less than a predetermined minimum threshold) and the level "1" when, on the other hand, the rotor of the generator 2 is rotating at a speed greater than the said threshold.

An exemplifying embodiment of the phase signal detector circuit 22 is illustrated in Figure 3 and will be described in greater detail hereinafter.

Turning now to Figure 2, the output from the phase signal detector circuit 22 is connected to a first input 23a of a processing and comparison circuit 23. The said circuit has a further input 23b connected to the terminal of the resistor R which is connected to the emitter of the transistor T.

The output from the comparison circuit 23 constitutes the output of the entire circuit 18 and it is connected to an input of the driver circuit 15.

As will become more clearly apparent hereinafter, the processing and comparison circuit 23 is arranged to condition the conduction of current through the transistor T in such a way that the strength of the current flowing through the field coil is varied according to the speed of rotation of the rotor of the generator 2. In particular, the said comparison circuit 23, through the driver circuit 15 controls the conduction of current through the transistor T in such a way that the said transistor is driven

- in a first mode which corresponds to fairly low peak levels of field current, for example between 300 to 500 mA, when the phase signal applied to the input PH of the monitoring circuit 3 indicates that the speed of rotation of the rotor of the generator is nil or less than a minimum preset threshold and
- in a second mode which corresponds to peak values of the field current which are on average higher, for example between 4.75 and 5.25 A, when the phase signal indicates that the speed of rotation of the rotor of the generator is greater than the above-mentioned preset threshold and therefore the generator is effectively operating.

The processing and comparison circuit 23 drives the transistor T in the aforesaid first mode when the signal provided at the output from the detector circuit of the phase signal 22 is at level "O", and in the second mode when the said signal is at level "1".

In the case of the embodiment shown in Figure 3, the detector circuit of the phase signal 22 comprises a low-pass filtering circuit 24 which serves to eliminate the full switching stages present in the input signal due to switching of the power transistor T.

The filtering circuit 24 in the embodiment

shown comprises a delay circuit 25 connected between the output of the threshold comparator 19 and a first input of a logic AND gate 26. The circuit 25 for example introduces a delay of 20 microseconds.

The other input of the AND gate 26 is connected to the output from the comparator circuit 19.

Connected to the output from the filtering circuit 24 is a logic circuit 27 for detecting leading and trailing edges of the signal applied to its input. The said circuit comprises a delay circuit 28 the input of which is connected to the output from the AND gate 26, and the output of which is connected to a first input of an EXOR 29, the other input of which is connected to the output form the AND gate 26. The circuit 28 introduces, for instance, a delay of 20 microseconds. Correspondingly, in the operation at the output form the EXOR gate 29 there is a train of pulses with a pulse of 20 microseconds duration for each leading and trailing edge presented by the signal at the output from the AND gate 26.

The output from the circuit 27 is connected to the input of a control circuit 30 comprising two bistable circuits (flip-flop, type D) 31 and 32 and a logic AND gate 33, connected inter se in the manner illustrated. Connected to an input of the AND gate 33 is the output from an oscillator 34 which has a frequency of 80 Hz for example.

In operation, when the control circuit 30 receives a first pulse from the logic circuit 27, the output Q from the bistable circuit 32 moves to high level ("1") and remains in that state if every subsequent input pulse occurs at the latest within a time equal (in the example illustrated in Figure 3) to twice the cycle of the oscillator 34. When the interval between two successive pulses received at the input of the circuit 30 is greater than two cycles of the oscillator 34, the output Q from the flip-flop 32 passes to level "O". In practice, this situation occurs when the rotor of the generator 2 is stopped or is rotating fairly slowly, at a speed below a minimum predetermined threshold.

With reference to Figure 4, in a first embodiment, the processing and comparison circuit 23 comprises two amplifiers 35 and 36 which have respective and different gain values G1 and G2, connected on the input side to the emitter of the transistor T. The outputs from the said amplifiers are connected to the inputs of a switching device 37 having a further control input 37a connected to the output from the phase signal detector circuit 22. The output from the said selective switching device is connected to an input of a threshold comparator circuit 38, to the other input of which there is connected a direct current reference voltage source 39.

If the amplifier 35 has a greater gain than the amplifier 36 when the signal supplied at the output from the circuit 22 at level "O" and at level "1" respectively, the switching device 37 selectively couples to the input of the threshold comparator 38 the output of the amplifier 35 or, respectively, the output of the amplifier 36. Therefore, when the generator 2 is stopped or is turning at an extremely low speed, the threshold comparator, with hysteresis 38, compares with its reference levels a field current indicator signal, the said signal being greatly amplified in respect of the situation in which the generator 2 is operating. This is equivalent to comparing the field current with the very lowest thresholds and with a narrower hysteresis beam when the generator is stopped or almost stopped. Consequently, the driving signal which passes from the output of the comparator 38 to the base of the transistor T through the circuit 15 is such that it reduces the conduction time of the said transistor and therefore maintains the mean value of the peak current in its collector-emitter path within a preset range, for example between 300 and 500 mA as stated hereinabove.

When the generator 2 is functioning at a speed greater than the minimum preset threshold, the comparator 38 compares its thresholds and its hysteresis band with a relatively less amplified signal. This is equivalent to comparing the field current with greater thresholds and a wider hysteresis band than in the situation where the generator is stopped or almost stopped. Consequently, the comparator 38 keeps the transistor T conductive for longer times and consequently the peak intensity of the field current may vary within clearly greater limits than in the preceding case, for example between 4.74 and 5.25 A, as stated hereinabove.

In the processing and comparison circuit 23 shown in Figure 4, the amplifier 36 could at the limit, be omitted and the corresponding input of the selective switching device 37 could be connected directly to the emitter of the transistor T.

Shown in Figure 5 is an alternative embodiment of comparison circuit 23.

In the said alternative, there are connected to the emitter of the transistor T two threshold comparator circuits 40 and 41 having the same threshold levels and the same band of hysteresis. The comparator 40 is connected to the emitter of the transistor T through an interposed amplifier circuit 42 having for example a gain G equal to 10. The comparator 41 is however connected directly to the emitter of the said transistor.

The outputs from the threshold comparators 40 and 41 are connected to corresponding inputs of an OR circuit 43 through a switching device 37 and directly, respectively. The switching device 37 is also in this case, controlled by the output from the

circuit 22. In particular when the signal supplied at the output from the circuit 22 is at level "O" (generator stopped or almost stopped), the device 37 couples a first input of the OR gate 43 to the output from the threshold comparator 40. On the other hand, when the signal supplied by the circuit 22 is at level "1" (generator running), the device 37 couples the said input of the OR gate 43 to earth.

The output from the OR gate 43 is connected to the input of a driver circuit 44 of the chopper type comprising two bistable circuits (flip-flop of the set/reset type) 45 and 46, connected in the manner illustrated and an oscillator 47, the output from which is connected to the set inputs of the circuits 45 and 46 directly and through an inverter 48 respectively.

The output from the OR gate is connected to the reset input R of the bistable circuit 45.

The output Q from the bistable circuit 46 represents the output from the driver circuit 44 as a whole.

When, in operation, the generator 2 is stopped or almost stopped, the output from the comparator 41 is maintained constantly at level "O", and therefore the chopper control circuit 44 is driven, practically, only by the output from the threshold comparator 40, through the selective switching device 37 and the OR gate 43.

On the other hand, when the generator 2 is functioning properly, the switching device 37 disconnects the output from the comparator 40 of the chopper control circuit 44, which is driven by the output from the threshold comparator 41.

In either case, the circuit 44 is "set" by the signal form the clock 47 (the frequency of which is 640 Hz for example) and it is then "reset" by the signal provided by the comparator 40 or by the comparator 41 when the field current exceeds the threshold.

By an appropriate selection of the gain of the amplifier 42 and of the reference voltage associated with the comparators 40 and 41, it is possible to ensure that the transistor T is so driven that it maintains the peak current in its collector-emitter path at an average of between 300 and 500 mA for example when the alternator is stopped or almost stopped and between 4.75 and 5.25 A for example when the alternator is operating.

Naturally, while the principle of the invention remains established, the embodiments and details of implementation may be varied widely compared with what has been described and illustrated purely by way of non-limitative example, without thereby departing from the scope of the present invention.

Claims

1. A monitoring circuit for a motor vehicle battery recharging system which comprises an electrical generator (2) including an alternator (4) with an induction coil (5) and a field coil (6) and a rectifier (7), the output (A) of which is connected to the battery (1); the monitoring circuit (3) comprising

   a driver transistor (T), the collector-emitter path of which is intended to be connected in series to the field coil (6) of the generator (2) between the two terminals of a direct current voltage source,

   sensor means (R) adapted to provide a signal indicative of the current flowing during operation of the said field coil (6) and

   driver circuit means (14-18) adapted to drive the said transistor (T) in accordance with predetermined procedures as a function of the value assumed by the voltage produced by the said generator (2) and the signal provided by the said field current sensor means (R);

   characterised in that the said driver circuit means (14-18) comprise

   a detector circuit (19-22) connected to a phase of the generator (2) and adapted to provide a signal indicative of the rotary speed of the generator (2) and

   a processing and comparison circuit (23) coupled to the said detector circuit (19-22) and adapted to generate a signal for controlling the conduction of current through the said transistor (T) so that the intensity of the current flowing through the collector-emitter path of the said transistor (T) varies as a function of the rotary speed of the said generator (2).

2. A monitoring circuit according to Claim 1, characterised in that the said processing and comparison circuit (23) is predisposed to generate a signal for controlling the conduction of current through the said transistor (T) in such a way that the said transistor (T) is driven
   - in a first mode which, when functioning, corresponds to a predetermined average low value of the peak current in the field coil (6), when the rotary speed of the generator (2) is below a preset level and
   - in a second mode corresponding to a preset upper mean value of the said peak current when the speed of rotation of the generator (2) is greater than the said preset level.

3. A monitoring circuit according to Claim 2, characterised in that the said detector circuit comprises a first threshold comparator circuit (19) with a first input connected to a phase of the generator (2) and a second input connected to a reference direct current voltage source (20);

a logic circuit (27) connected to the output of the said first threshold comparator circuit (19) and adapted to generate a pulse corresponding to each leading and/or trailing edge of the output signal from the said first threshold comparator circuit (19) and

an actuating circuit (30) connected to the said logic circuit (27) and adapted to provide a first or a second logic actuating signal (0,1) when the interval of time between two successive pulses of the signal provided by the said logic circuit (27) is less or greater than a preset value.

4. A monitoring circuit according to Claim 3, characterised in that there is connected to the said first input of the first threshold comparator circuit (19) a current source (21) adapted to neutralise the effect of any leakage currents from the rectifier (7, 8).

5. A monitoring circuit according to Claim 3 or 4, characterised in that interposed between the first comparator circuit (19) and the said logic circuit (27) is a low-pass filtering circuit (24).

6. A monitoring circuit according to one of Claims 3 to 5, in which said means for sensing the current flowing through the field coil (6) comprise a resistor (R) disposed in series with the collector-emitter path of the said transistor (T), characterised in that the said processing and comparison circuit (23) comprises

first and second amplifiers (35, 26) with different gains and inputs connected to the said resistor (R);

a second threshold comparator circuit (38) connected to a reference direct current voltage source (39) and

a switching device (37) interposed between the outputs from the said amplifiers (35, 36) and the input of the said second threshold comparator circuit (38) and having an actuating input (37a) coupled to the output from the said detector circuit (22) so that, when the said detector circuit (22) emits the aforesaid first or said second actuating signal, the switching device (37) selectively couples the output from the first or second amplifier (35 or 36) to the input of the said second threshold comparator circuit (38).

7. A monitoring circuit according to one of Claims 3 to 5, in which the said means for sensing the current flowing through the field coil (6) comprise a resistor (R) in series with the collector-emitter path of the said transistor (T), characterised in that the said processing and comparison circuit (23) comprises

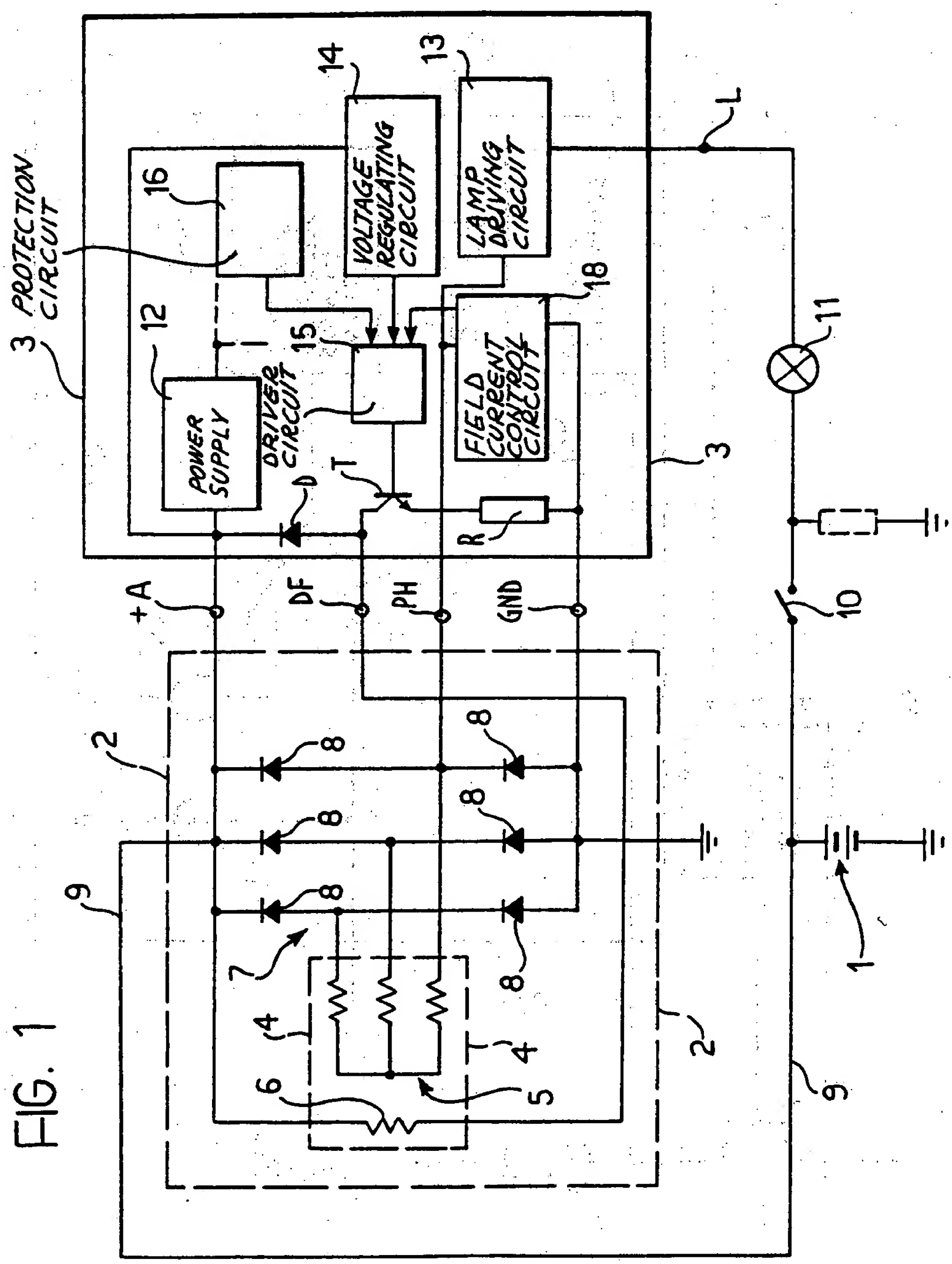
an amplifier (42) connected to the said resistor (R),

second and third threshold comparator circuits (40, 41) with which there is associated a direct-current reference voltage source, the said comparator circuits being connected on the input side to the output from the said amplifier (42) and the said resistor (R) respectively,

a chopper-type driver circuit (44) the output of which is capable of influencing the conduction of current through the said transistor (T) and

a switching device (37) which controls the connection between the output from at least one of the said second or third threshold comparators (40, 41) and the actuating input of the said chopper-driver circuit (44).

8. A monitoring circuit according to Claim 7, characterised in that associated with the said second and third threshold comparators (40, 41) are low-pass filtering means adapted to neutralise any stray pulses due to the selective switching of the said transistor (T).


PROTECTION CIRCUIT
POWER SUPPLY
DRIVER CIRCUIT
VOLTAGE REGULATING CIRCUIT
LAMP DRIVING CIRCUIT
FIELD CURRENT CONTROL CIRCUIT
+A
DF
PH
GND
L
T
D
R
1
2
3
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7
8
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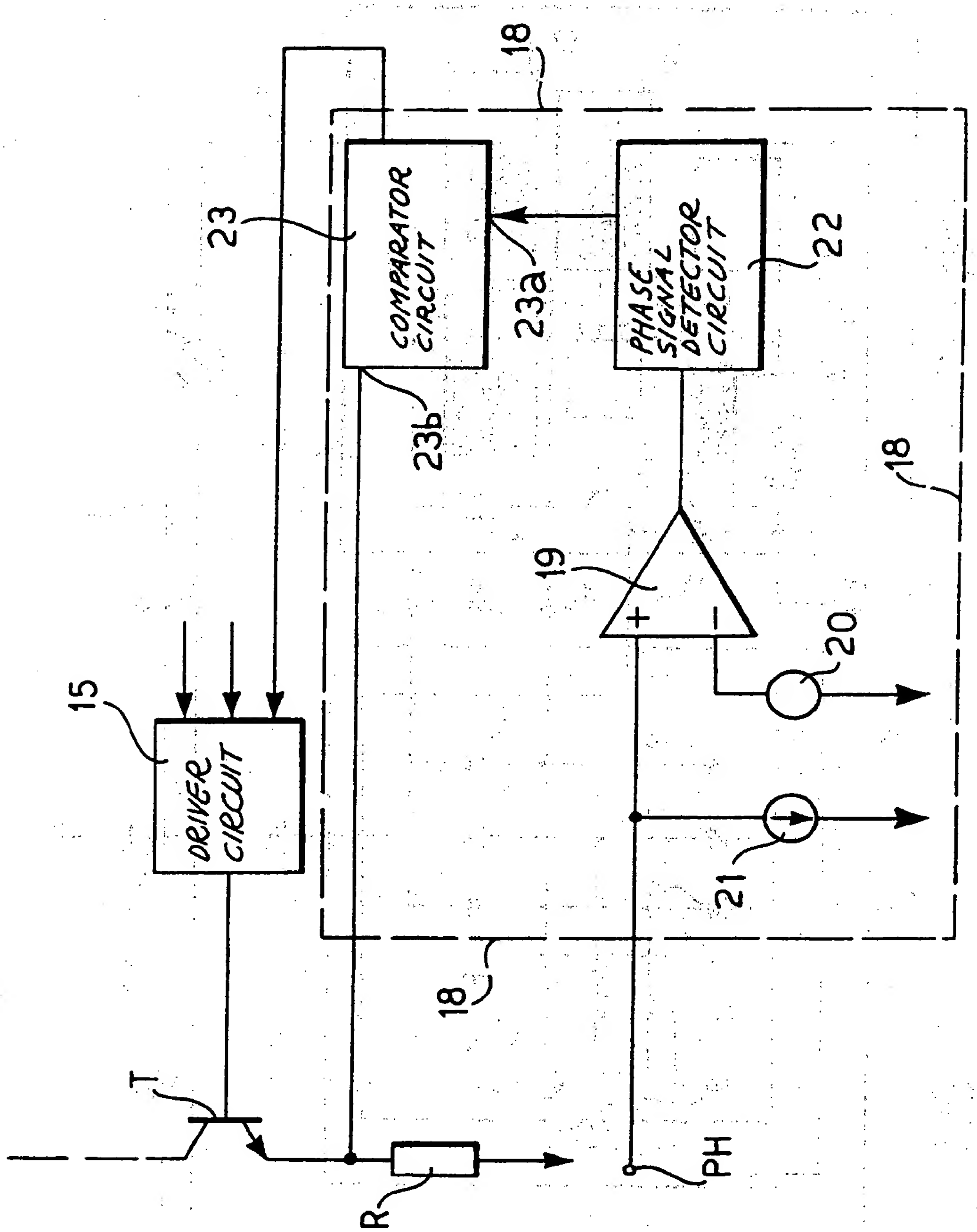
10
11
12
13
14
15
16
18

FIG. 1

FIG. 2


COMPARATOR CIRCUIT
PHASE SIGNAL DETECTOR CIRCUIT
DRIVER CIRCUIT
15
18
19
20
21
22
23
23a
23b
T
R
PH

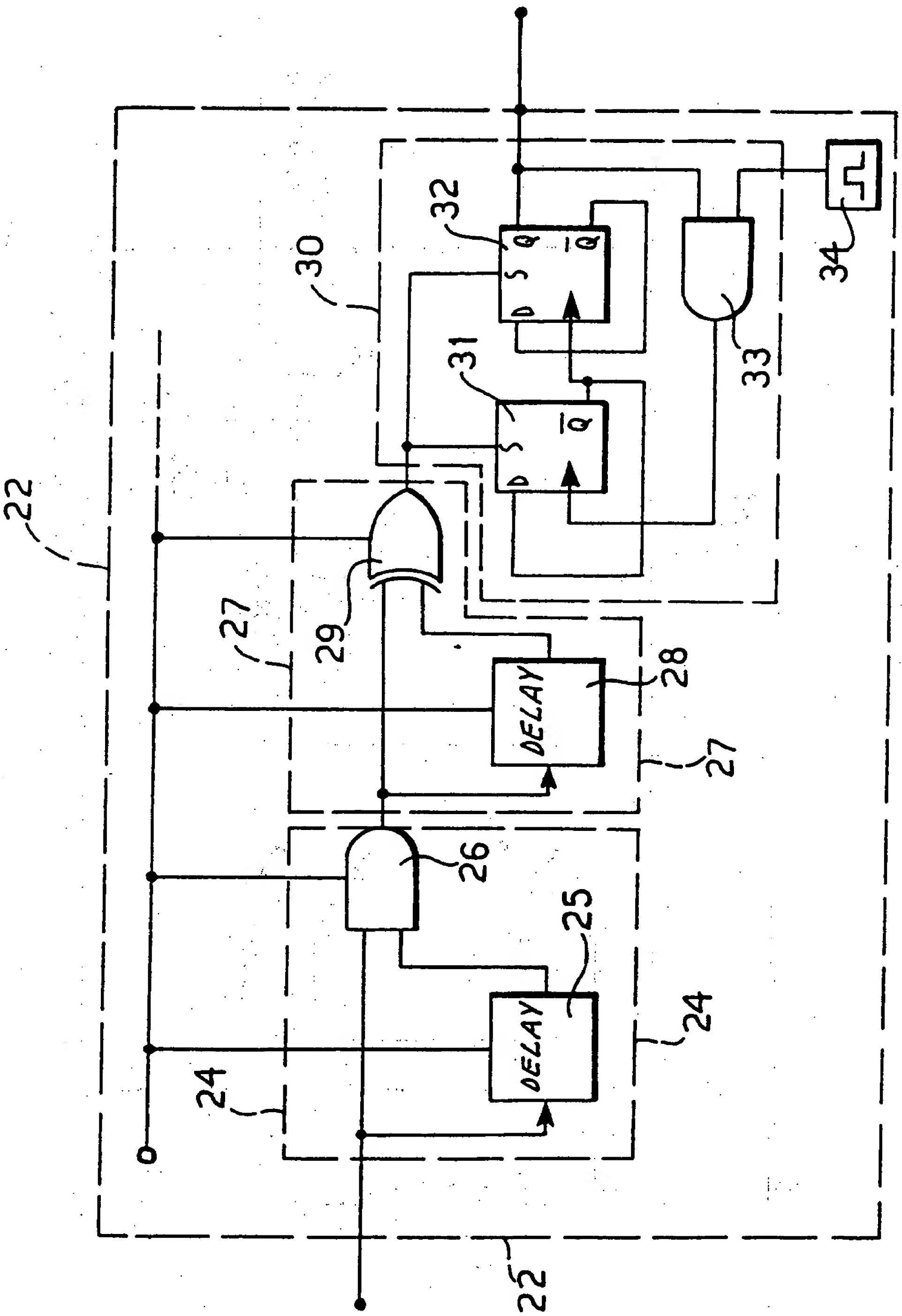


FIG. 3

FIG. 4

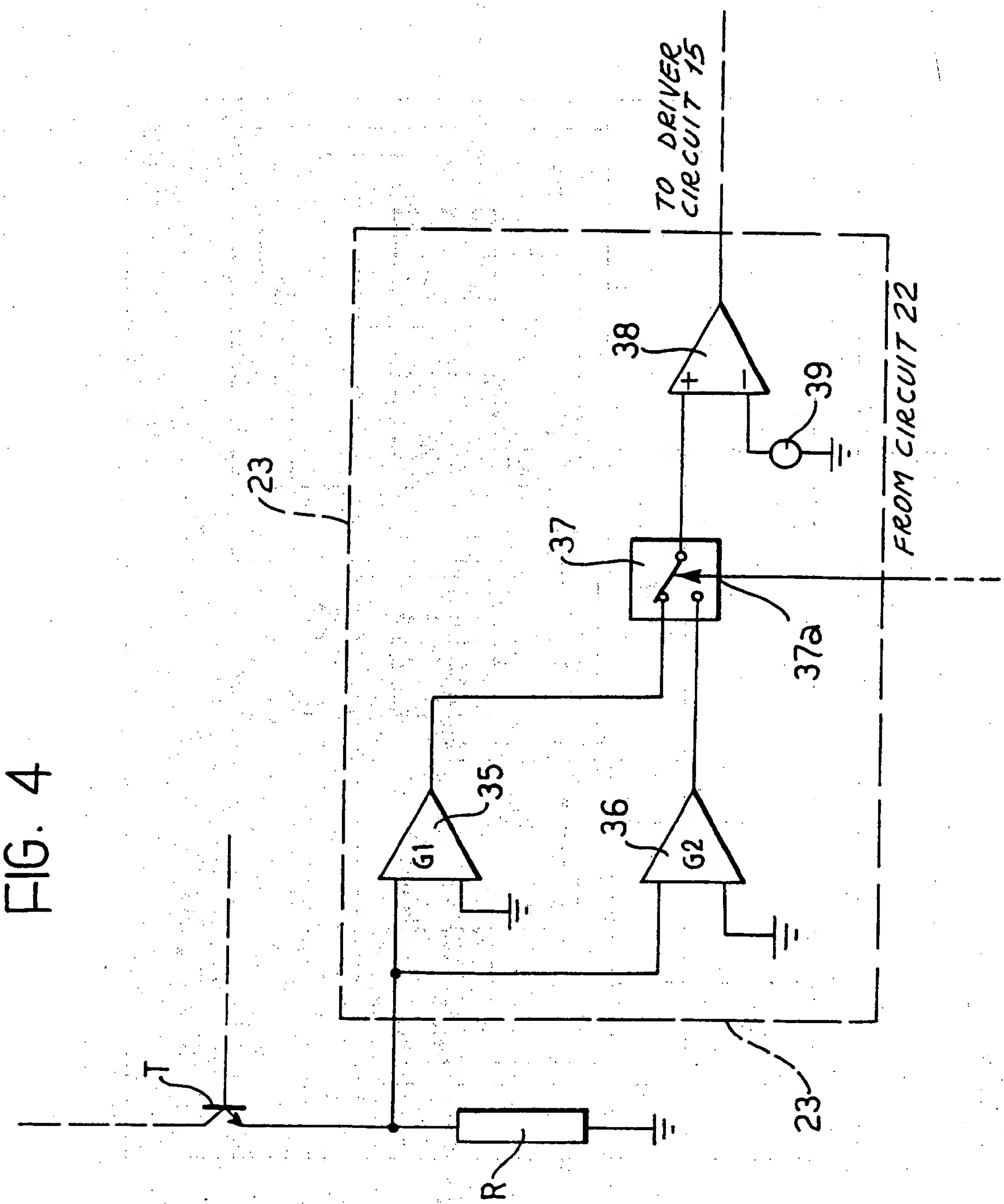
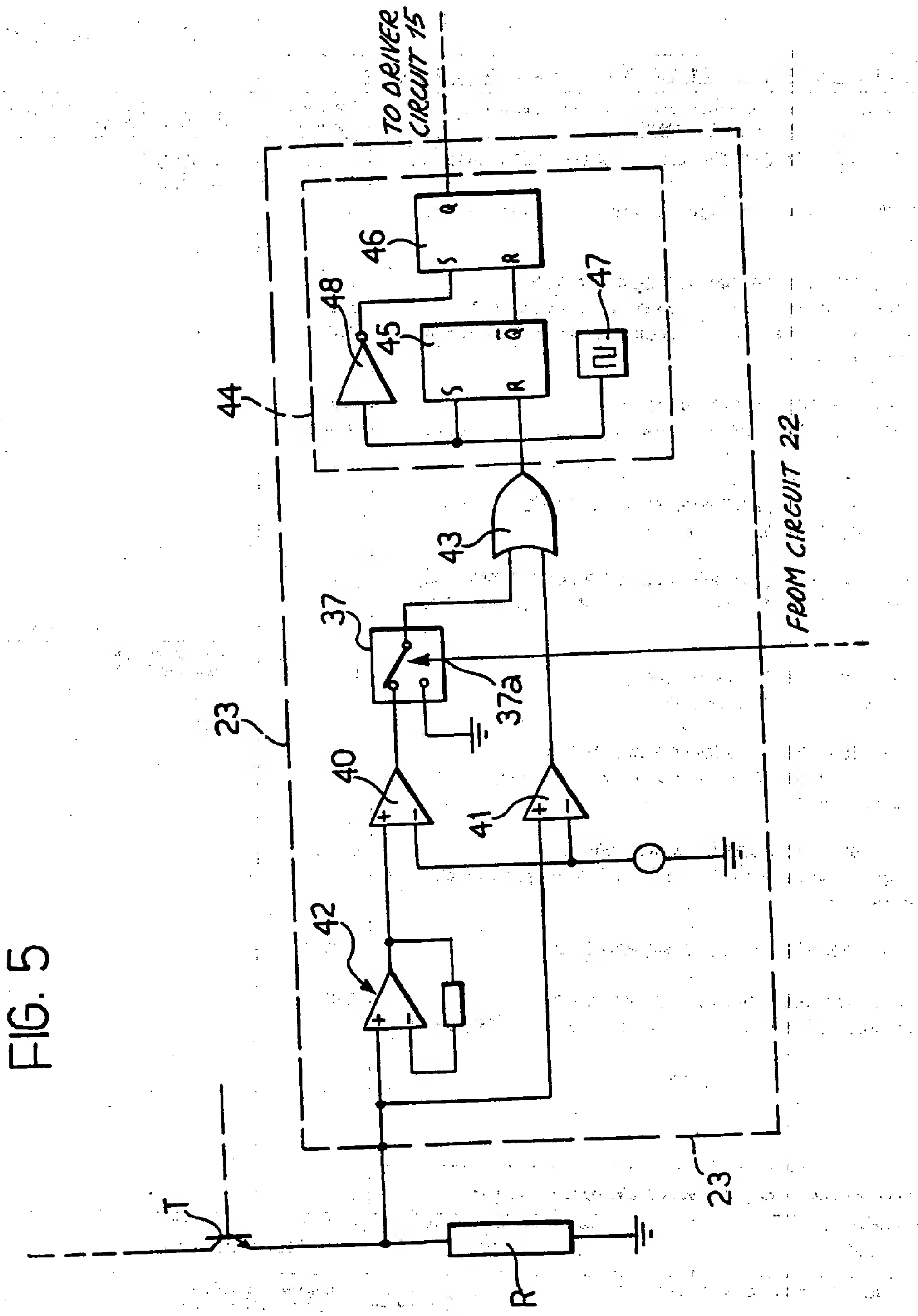

TO DRIVER CIRCUIT 15
FROM CIRCUIT 22
23
37
37a
38
39
+
−
35
36
G1
G2
T
R
23

FIG. 5


TO DRIVER CIRCUIT 15
FROM CIRCUIT 22
44
46
48
45
47
43
37
37a
23
40
41
42
23
T
R

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 10 6604

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X Y	EP-A-0 116 482 (EQUIPEMENTS AUTOMOBILES MARCHAL) * page 1, line 3 - page 9, line 11; figures 1-3 *	1,2,3 4,5	H02J7/24 H02J7/16
X Y A	EP-A-0 289 608 (MISUBISHI DENKI K.K.) * page 1, paragraph 1 - page 5, paragraph 1 * * page 9, paragraph 2 - page 11, last paragraph; figure 5 *	1 2-5 4-8	
Y A	US-A-4 477 766 (AKITA ET AL.) * column 2, line 33 - column 7, line 13; figures 1,2 *	2-4 1,5-8	
Y	EP-A-0 330 561 (EQUIPEMENTS ELECTRIQUES MOTEUR) * page 8, line 36 - line 45 *	5	
A	FR-A-2 555 834 (EQUIPEMENTS AUTOMOBILES MARCHAL) * page 1, line 4 - page 4, line 21; figures 1,8 *	1-8	
A	DE-A-3 722 762 (HITACHI LTD.) * claims 1-4; figures 1-7 *	1-8	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	GB-A-2 164 508 (NIPPODENSO CO. LTD.) * page 1, line 93 - line 117; claims 1-7; figures 1-4 *	1-8	H02J
A	WO-A-8 801 110 (ROBERT BOSCH GMBH) * page 2, paragraph 3 - page 6, last paragraph; figure 1 *	1-8	
A	EP-A-0 448 065 (MARELLI AUTRONICA S.P.A.)	1-8	
E,D	EP-A-0 483 081 (MARELLI AUTRONICA S.P.A.) * column 1, line 1 - column 3, line 16; figure *	1-8	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28 JULY 1992	SCHOBERT D.A.V.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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